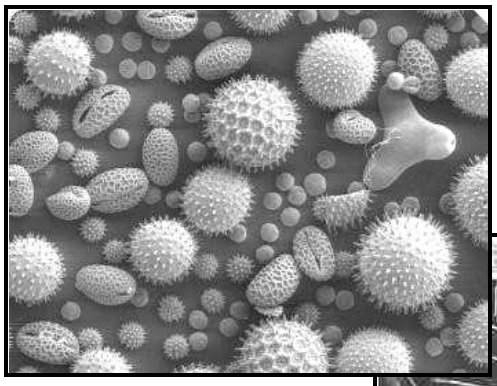
The Climate Time Machine Activity

Using fossil pollen to study climate change

In the spring time, pollen signifies the long awaited arrival of warm weather. For some, pollen means unpleasant allergies. For paleoclimatologists, scientists who study past climates, pollen is like a climate time machine!



Pollen that settles on top of a water body eventually drops to the bottom where it gets trapped in the sediment. As sediment and pollen accumulate, the annual layers increase in thickness. Paleoclimatologists extract long tubes of sediment cores, and use them to figure out how climate conditions might have changed over time. The fossilized pollen is extracted and identified to see what plant species were prevalent in the past. Because scientists know the climate conditions that species prefer, they can infer what the climate was like during those time periods.

In "The Climate Time Machine" activity, students will look for "simulated pollen in lake sediment". Based on actual pollen data collected from Battleground Lake in southwest Washington, students will track how the climate has changed 20,000 years ago to the present. Use these instructions to prepare this activity for your students. *For scientific research extension, check out this neat internet site:* ***www.ngdc.noaa.gov/paleo/pubs/williams2004/williams2004.html***

Actual Sediment Core

Time: one hour prep, one hour for activity

Materials needed:

- Pictures of several types of pollen, (found on any internet search engine)
- One large graduated cylinder or tube to "simulate lake sediment" core (picture at right, click for larger view)
- Pie tins or sample pans (one for each of the five sediment samples, more if your class is large)
- Eleven different colors of paper "dots" (construction paper and a hole punch)
- Powdered Chalk (five different colors to represent the five different sediment layers)
- Salt (~5 pounds)
- Plastic quart size freezer bags for storing sediment samples
- Information sheets: Table 1, Table 2, data sheets, and Climate/Vegetation info cards

Materials Prep:

1. Make "simulated sediment" by placing salt in a plastic bag with powdered chalk. You will need enough colored salt to make sediment samples for students plus optional sediment core. A great description to make the colored salt can be found at http://www.theideabox.com/ideas.nsf/seasonal/30d3d982c233d26e8625665200112ff9.
2. Layer and label five different colors of salt/chalk in sediment tube to create "sediment core"
3. Bag and label salt/chalk into five bags and label with the age range the "sediment" represents (Info sheet—Table 2).
4. Following table 2, assign each species a corresponding color of construction paper dots. Be sure to write down the colors to avoid later confusion. Place corresponding number of dots for each species into the correct bag of sediment.

Procedure

- Divide students into five teams. Distribute one sediment sample and one pan/tin to each group of students. Students can then empty the contents of their sample into the tin, separating the pollen from the sediment.
- Students must record the color and amount of pollen found, and the age of their sediment layer on a data sheet.
- Using Table 1, students can then iden tify the plant species which the colored pollen represents. Based on the climate conditions each species prefers and the amount of pollen found that belongs to that species students should infer what the climate was like during that particular time period. Using climate/vegetation information cards, students can label their period with a "climate number" of 1 – 10, 1 being very cold, 5 being similar to current climate in Southwest Washington. Collectively, students can compare their results and can graph how vegetation and climate has changed over time.

Table 2: Battleground Lake Study: Pollen/Vegetation Distribution

Sediment Layer	Plant Species	Dot Color	# Simulated Pollen Grains—Dots	Percentage
5 (4,500 years before present (ybp) to present	Cedar Hemlock Douglas Fir Alder		6 5 10 4	25 20 40 15
4 (4,500 ybp to 9,500 ybp)	Douglas Fir Oak Mixed Meadow Species		3 3 19	10 10 80
3 (9,500 ybp to 11,200 ybp)	Douglas Fir Grand Fir Alder		7 5 13	30 20 50
2 (11,200 ybp to 15,000 ybp)	Lodgepole Pine Englemann Spruce Grasses & Sedges Alpine Sagebrush		7 3 3 9 3	30 15 15 30 10
1 (15,000 ybp to 20,000 ybp)	Grasses & Sedges Alpine Sagebrush Lodgepole Pine Englemann Spruce		15 4 4 2	60 15 15 10

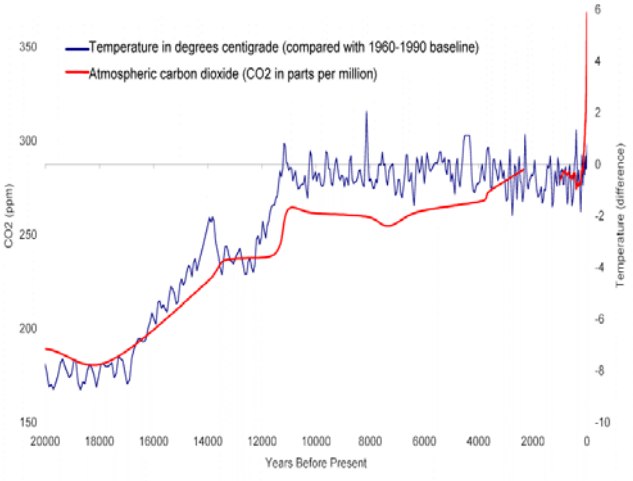
Table 1: Pollen Key and Climatic Characteristics, SW Washington Pollen Research Study

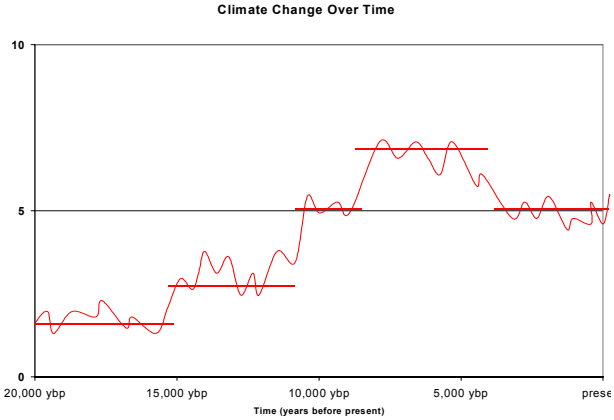
Species	Climate Characteristics
Western Hemlock	Principal dominant tree of lowland, temperate conditions. Requires very moist, temperate conditions for growth.
Douglas Fir	Broadly distributed throughout Pacific Northwest from moderately cool to warm sites. Grows best under temperate, somewhat moist conditions.
Grasses & Sedges	This pollen from grasses and sedges typically found in very cool alpine/subalpine meadow sites characterized by very cool summers, harsh winters, and short growing seasons
Alder	Widespread throughout Northwest, often colonizing gravel bars or other poor soils. Prefers abundant water and can grow in cool climates.
Grand Fir	Found at mid-level elevations in Cascade Mountains. Grows in cool climates, but not as cold tolerant as trees found at higher altitudes.
Englemann Spruce	Found in cold, usually subalpine sites. It is an important timberline species in the Rocky Mountains.
Western Red Cedar	Found only in temperate, very moist climates.
Lodgepole Pine	Found in areas of very cool climates typically growing in poor soils, often at high altitudes (above 3500 feet) under present climate.
Mixed Meadow Species	This pollen is typical of a mixture of herbaceous plants common to warm-temperate meadowlands. Typically, these species grow in areas of warm summer temperatures and summer drought.
Oak	Found in warm-temperature sites characterized by dry, warm summers.
Alpine Sagebrush	Woody, low growing shrub found only at high-altitude, cold sites.

Reference: Global Climate—Past, Present & Future, S. Henderson et al; EPA Report 600/72-83/726

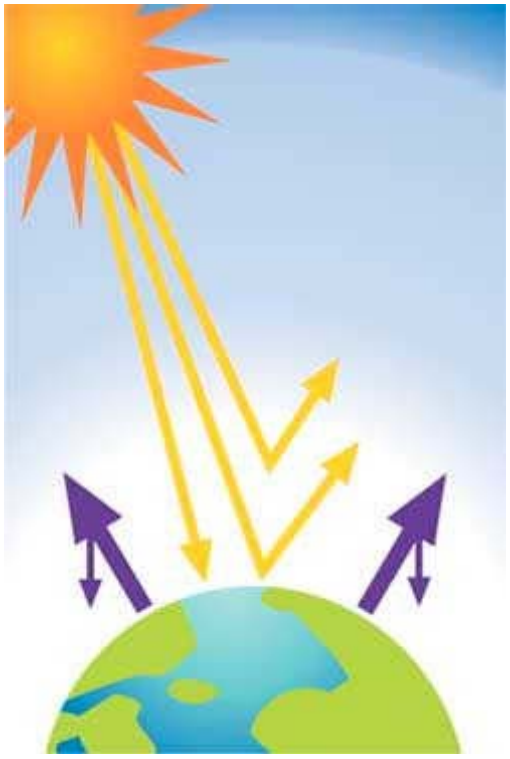
Discussion:

1. On the blank graph, have a representative of each group draw in their temperature number for their assigned time period. A student produced graph is located here.
2. Ask students about the graph they created. Does the climate remain flat from year to year? What do you think a climate map should look like? Have a student draw in the peaks and valleys of a varying climate over time.





3. Superimpose an actual graph scientists created. The graph can be obtained directly from http://www.brighton73.freeserve.co.uk/gw/paleo/20000yrfig.htm where there is an explanation of how data for that graph was obtained. Blue line is temperature, red is carbon dioxide. Both climate graphs should look similar. Impressive work done by the class!
4. Students then can discuss the differences/ similarities in tempreature vs. CO2. A sharp rise in CO2 is seen on the graph. This is a good lead in to a discussion of the greenhouse effect and global warming.



The Greenhouse Effect is a completely natural process. Without it, the Earth would not be inhabitable. But what happens when the Greenhouse Effect is enhance with extra greenhouse gases like carbon dioxide from fossil fuels? The Earth can get too warm, too fast.